

WHAT IS CLAIMED IS:

1. A computerized method for assigning observations comprising:

receiving a plurality of first observations
5 indicative of respective physical parameters observed by
a first sensor system and receiving a plurality of second
observations indicative of respective physical parameters
observed by a second sensor system;

assigning, by a computer, a set of pairs of the
10 first and second observations predicted to correspond to
the same physical parameter, the assigning comprising:

receiving a cost function that specifies a cost
for each assigned pair, the cost not independent of
the assignment of any other assigned pairs in the
15 set of assigned pairs; and

determining the set of assigned pairs
corresponding to an optimal value for the cost
function by calculating, by the computer, a
corresponding optimal value for a directed graph
20 representative of possible assignments of first and
second observations.

2. The method of Claim 1, wherein the directed
graph comprises a plurality of nodes each representing an
25 assignment hypothesis, the plurality of nodes comprising
a root node, wherein each node except for the root node
has an associated input arc representing an assignment
decision and wherein the length of each input arc is
representative of a change in an assignment score
30 resulting from the assignment decision, wherein the
plurality of nodes are grouped in a plurality of stages.

3. The method of Claim 1, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of first and second observations comprises calculating the optimal value by a network shortest path algorithm.

4. The method of Claim 1, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of first and second observations comprises calculating the optimal value by a Dijkstra algorithm.

5. The method of Claim 1, wherein the cost function is

$$J_{s=} - \bar{x}R^{-1}\bar{x}^T - \sum_{i=1}^s \left\{ \frac{\delta x_i S_i^{-1} \delta x_i^T + \ln |S_i|}{\bar{g}} - \ln(d_{\min}) \right\} \begin{matrix} a(i) \neq 0 \\ a(i) = 0 \end{matrix} + \begin{cases} \ln([2\pi]^M |R|) & n_a = 0 \\ 0 & n_a > 0 \end{cases}$$

wherein

J_s	=	Assignment score
\bar{x}	=	Estimate of relative bias
R	=	Relative registration covariance matrix
δx_i	=	State vector difference = $A_i - B_{a(i)} - \bar{x}$
S_i	=	Residual error covariance for pair A_i and $B_{a(i)}$
d_{\min}	=	Minimum determinant of a residual error matrix
g	=	Gate value
M	=	Number of first observations
n_a	=	Number of non-zero entries in a
a	=	Assignment vector: $a_{(i)} > 0 \rightarrow A_i$ is assigned to $B_{a(i)}$
A_i	=	The plurality of first observations
$B_{a(i)}$	=	The plurality of second observations assigned to A_i

6. The method of Claim 5, wherein the relative bias, \bar{x} , of the cost function is a simple bias.

5 7. The method of Claim 5, wherein the relative bias, \bar{x} , of the cost function is a functional bias.

10 8. The method of Claim 1, wherein assigning, by a computer, comprises assigning by a processor operable to execute a computer program stored on a computer readable medium.

15 9. The method of Claim 1, wherein assigning, by a computer, comprises assigning by an application specific integrated circuit.

10. The method of Claim 1, wherein assigning, by a computer, comprises assigning by a digital signal processor.

11. A computerized method for determining the N-best observation assignments comprising:

receiving a plurality of first observations indicative of respective physical parameters observed by
5 a first sensor system and receiving a plurality of second observations indicative of respective physical parameters observed by a second sensor system;

determining, by a computer, one or more sets of pairs of the first and second observations predicted to
10 correspond to the same physical parameter, the determining comprising:

receiving a cost function that specifies a cost for each assigned pair;

determining a set of assigned pairs
15 corresponding to an optimal value for the cost function by calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of corresponding first and second observations; and

20 repeating the determining act until a desired number of best observation assignments is determined.

12. The method of Claim 11, wherein the cost
25 specified by the cost function for each assigned pair is not independent of the assignment of any other assigned pairs in the respective set of assigned pairs.

13. The method of Claim 11, wherein the directed graph comprises a plurality of nodes each representing an assignment hypothesis, the plurality of nodes comprising a root node, wherein each node except for the root node
5 has an associated input arc representing an assignment decision and wherein the length of each input arc is representative of a change in an assignment score resulting from the assignment decision, wherein the plurality of nodes are grouped in a plurality of stages.

10

14. The method of Claim 11, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of first and second observations comprises calculating the
15 optimal value by a network shortest path algorithm.

15. The method of Claim 11, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of
20 first and second observations comprises calculating the optimal value by a Dijkstra algorithm.

16. The method of Claim 11, wherein the cost function is

$$J_s = -\bar{x}R^{-1}\bar{x}^T - \sum_{i=1}^s \left\{ \frac{\delta x_i S_i^{-1} \delta x_i^T + \ln[|S_i|] - \ln(d_{min})}{\bar{g}} \begin{matrix} a(i) \neq 0 \\ a(i) = 0 \end{matrix} \right\} + \left\{ \begin{matrix} \ln([2\pi]^M |R|) & n_a = 0 \\ 0 & n_a > 0 \end{matrix} \right\}$$

wherein

5	J_s	=	Assignment score
	\bar{x}	=	Estimate of relative bias
	R	=	Relative registration covariance matrix
	δx_i	=	State vector difference = $A_i - B_{a(i)} - \bar{x}$
10	S_i	=	Residual error covariance for pair A_i and $B_{a(i)}$
	d_{min}	=	Minimum determinant of a residual error matrix
	g	=	Gate value
	M	=	Number of first observations
15	n_a	=	Number of non-zero entries in a
	a	=	Assignment vector: $a_{(i)} > 0 \rightarrow A_i$ is assigned to $B_{a(i)}$
	A_i	=	The plurality of first observations
20	$B_{a(i)}$	=	The plurality of second observations assigned to A_i

17. The method of Claim 16, wherein the relative bias, \bar{x} , of the cost function is a simple bias.

25 18. The method of Claim 16, wherein the relative bias, \bar{x} , of the cost function is a functional bias.

19. The method of Claim 11, wherein assigning, by a computer, comprises assigning by a processor operable to
30 execute a computer program stored on a computer readable medium.

Attorney's Docket No.
BB No. 064749.0141
Client No. PD 02E002

PATENT APPLICATION

38

20. The method of Claim 11, wherein assigning, by a computer, comprises assigning by an application specific integrated circuit.

5 21. The method of Claim 11, wherein assigning, by a computer, comprises assigning by a digital signal processor.

22. A system for assigning observations comprising:
a computer readable medium; and
a computer program stored on the computer readable
medium, the computer program operable, when executed on a
5 processor, to:

receive a plurality of first observations
indicative of respective physical parameters
observed by a first sensor system and receiving a
plurality of second observations indicative of
10 respective physical parameters observed by a second
sensor system;

assign a set of pairs of the first and second
observations predicted to correspond to the same
physical parameter, the assignment comprising:

15 receiving a cost function that specifies a
cost for each assigned pair, the cost not
independent of the assignment of any other
assigned pairs in the set of assigned pairs;
and

20 determining the set of assigned pairs
corresponding to an optimal value for the cost
function by calculating, by the computer, a
corresponding optimal value for a directed
graph representative of possible assignments of
25 first and second observations.

23. The system of Claim 22, and further comprising
a processor operable to execute the computer program.

24. The system of Claim 22, wherein the directed graph comprises a plurality of nodes each representing an assignment hypothesis, the plurality of nodes comprising a root node, wherein each node except for the root node
5 has an associated input arc representing an assignment decision and wherein the length of each input arc is representative of a change in an assignment score resulting from the assignment decision, wherein the plurality of nodes are grouped in a plurality of stages.

10

25. The system of Claim 22, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of first and second observations comprises calculating the
15 optimal value by a network shortest path algorithm.

15

26. The system of Claim 22, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of
20 first and second observations comprises calculating the optimal value by a Dijkstra algorithm.

20

27. The system of Claim 22, wherein the cost function is

$$J_s = -\bar{x}R^{-1}\bar{x}^T - \sum_{i=1}^s \left\{ \frac{\delta x_i S_i^{-1} \delta x_i^T + \ln[S_i]}{\bar{g}} - \ln(d_{min}) \right\} \begin{matrix} a(i) \neq 0 \\ a(i) = 0 \end{matrix} + \begin{cases} \ln([2\pi]^M |R|) & n_a = 0 \\ 0 & n_a > 0 \end{cases}$$

wherein

5 J_s = Assignment score

\bar{x} = Estimate of relative bias

R = Relative registration covariance matrix

δx_i = State vector difference = $A_i - B_{a(i)} - \bar{x}$

10 S_i = Residual error covariance for pair A_i and $B_{a(i)}$

d_{min} = Minimum determinant of a residual error matrix

g = Gate value

15 M = Number of first observations

n_a = Number of non-zero entries in a

a = Assignment vector: $a_{(i)} > 0 \rightarrow A_i$ is assigned to $B_{a(i)}$

A_i = The plurality of first observations

20 $B_{a(i)}$ = The plurality of second observations assigned to A_i

28. The system of Claim 27, wherein the relative bias, \bar{x} , of the cost function is a simple bias.

29. A system for assigning observations comprising:
a computer operable to receive a plurality of first
observations indicative of respective physical parameters
observed by a first sensor system and receiving a
5 plurality of second observations indicative of respective
physical parameters observed by a second sensor system;
and

wherein the computer is further operable to assign a
set of pairs of the first and second observations
10 predicted to correspond to the same physical parameter,
the assignment comprising:

receiving a cost function that specifies a cost
for each assigned pair, the cost not independent of
the assignment of any other assigned pairs in the
15 set of assigned pairs; and

determining the set of assigned pairs
corresponding to an optimal value for the cost
function by calculating, by the computer, a
corresponding optimal value for a directed graph
20 representative of possible assignments of first and
second observations.

30. The system of Claim 29, wherein the computer
comprising an application specific integrated circuit.

25

31. The system of Claim 29, wherein the computer
comprises a processor operable to execute a computer
program stored on the computer readable medium.

30 32. The system of Claim 29, wherein the computer
further comprises the computer readable medium.

33. The system of Claim 29, wherein the computer comprises a digital signal processor.

5 34. The system of Claim 29, wherein the computer comprises a field programmable gate array.

10 35. The system of Claim 29, wherein the computer comprises a means for computing.

15 36. The system of Claim 29, wherein the directed graph comprises a plurality of nodes each representing an assignment hypothesis, the plurality of nodes comprising a root node, wherein each node except for the root node has an associated input arc representing an assignment decision and wherein the length of each input arc is representative of a change in an assignment score resulting from the assignment decision, wherein the plurality of nodes are grouped in a plurality of stages.

20 37. The system of Claim 29, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of first and second observations comprises calculating the optimal value by a network shortest path algorithm.

30 38. The system of Claim 29, wherein calculating, by the computer, a corresponding optimal value for a directed graph representative of possible assignments of first and second observations comprises calculating the optimal value by a Dijkstra algorithm.

39. The system of Claim 26, wherein the cost function is

$$J_s = -\bar{x}R^{-1}\bar{x}^T - \sum_{i=1}^s \left\{ \begin{matrix} \delta x_i S_i^{-1} \delta x_i^T + \ln[S_i] - \ln(d_{\min}) & a(i) \neq 0 \\ \bar{g} & a(i) = 0 \end{matrix} \right\} + \left\{ \begin{matrix} \ln[2\pi]^M |R| & n_a = 0 \\ 0 & n_a > 0 \end{matrix} \right\}$$

wherein

5	J_s	=	Assignment score
	\bar{x}	=	Estimate of relative bias
	R	=	Relative registration covariance matrix
	δx_i	=	State vector difference = $A_i - B_{a(i)} - \bar{x}$
10	S_i	=	Residual error covariance for pair A_i and $B_{a(i)}$
	d_{\min}	=	Minimum determinant of a residual error matrix
	g	=	Gate value
	M	=	Number of first observations
15	n_a	=	Number of non-zero entries in a
	a	=	Assignment vector: $a_{(i)} > 0 \rightarrow A_i$ is assigned to $B_{a(i)}$
	A_i	=	The plurality of first observations
20	$B_{a(i)}$	=	The plurality of second observations assigned to A_i

40. The system of Claim 39, wherein the relative bias, \bar{x} , of the cost function is a simple bias.